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# ***JPRS Report***

## **Science & Technology**

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***USSR: Electronics &  
Electrical Engineering***

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# Science & Technology

## USSR: Electronics and Electrical Engineering

JPRS-UEE-89-007

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#### Broadcasting, Consumer Electronics

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UDC 681.39:656.254.16

**Computer-Aided Calculation of Territorial Diversity of Radio Communication Ranges**  
*18600051b Moscow AVTOMATIKA TELEMEKHANIKA I SVYAZ in Russian No 8, Aug 88 pp 27-28*

[Article by G. V. Gorelov, doctor of technical sciences, docent, and P. M. Shmelev, engineer, Moscow Institute of Railroad Transportation Engineers]

[Abstract] A computer program has been written for fast calculation of the territorial diversity of railroad radio communication ranges in terms of interference immunity of the 150 MHz channel, according to the method outlined by Yu. V. Vavanov in the book "Communication with Moving Objects in Railroad Transportation System" and including approximation of a graphically depicted key relation. The program contains 81 addresses with a key and a code assigned to each. A typical problem can be solved within 20 s. Tables 2.

UDC 621.397.424.049.77

**Sensitivity Control of Television Cameras Built on Photosensitive Charge-Coupled Devices**  
*18600051a Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 88 pp 12-16*

[Article by V. D. Lobanov, Ye. V. Solovyev, N. Ye. Uvarov, and N. G. Khitrovo]

[Abstract] Automatic sensitivity control of television cameras built on matrix arrays of photosensitive charge-coupled devices is described, the control system consisting of two loops around the photosensitive array. The first loop consists of a video amplifier, an error signal meter, and an electromechanical drive for an objective with an iris. The electromechanical drive consists of a motor with a speed reducer and a power amplifier. The second loop consists of the same video preamplifier and error signal meter, with an electronic exposure regulator. The error signal meter compares the peak value of the video signal relative to the black level with a reference, the latter set close to the saturation voltage for the photosensitive array so as to minimize the effects of black level instability. Signals from high-energy point sources are limited before they enter the peak detector, which prevents degradation of the system dynamics with possible loss of details. The exposure regulator sets the exposure time to 14 ms and thus to 76 pct of the maximum possible length in the absence of a signal from the proportionally integrating filter behind the video preamplifier, which ensures linearity "in the small," the parasitic dark current being moreover minimized by optimization of the charging-voltage waveform rather than by cooling the photosensitive array. This is achieved by means of two sawtooth-voltage generators, a comparator, and a logic Or-gate. The system was tested in the laboratory with a light simulator. After refinement

of the voltage shaper, adaptation was achieved over a 60 dB range with a transient period not longer than 1.2 s and with 30-40 pct overregulation. Figures 4; references 7: 4 Russian, 3 Western.

UDC 771.449.2

**Series 'Yupiter' Motion-Picture Projectors**  
*18600051b Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 88 pp 28-31*

[Article by Ya. A. Blyuz and G. A. Zhabrovskiy, Central Design Office for Cinematography, Scientific-Industrial Association 'Ekran' (Screen), Kiev branch]

[Abstract] Development of series "Yupiter" motion-picture projectors was begun in 1985 and completed in 1987. The series consists of 17 models: 1) 5 with Fresnel lenses and 150-10,000 W quartz-halogen lamp, 2) 6 with Fresnel lenses and 200-7000 W metal-halide lamp, 3) 6 with reflex optics and 2000-7000 W metal-halide lamp. Each projector includes also an electrical circuit module, a case with a mount, and an apron. All 17 cases are identically constructed, made of aluminum parts assembled by spot welding. Noteworthy is the design of the projectors with metal-halide lamps, their electrical circuitry consisting of two separate devices: a flasher and a supply compensator. The flasher consists of a step-up transformer with an RC-filter on the primary side and a storing capacitor with a discharger on the secondary side, a pulse transformer energized by discharges on the primary side, and a capacitor protecting the network against high-voltage surges from the secondary of that pulse transformer. The supply compensator consists of a capacitor bank and a choke coil. Three flashers and five compensators with the same respective electrical circuit but of different sizes are available for the various projectors with those metal-halide discharge lamps. Figures 5; tables 4.

**'Elektronika VM-12' Video Cassette Recorder: Automatic Control System**  
*18600045a Moscow RADIO in Russian No 9, Sep 88 pp 35-38*

[Article by A. Solodov, Voronezh]

[Abstract] In this second part of the article is described the automatic control and monitoring system for "Elektronika VM-12" video cassette recorders. The system covers all phases and modes of operation: "stop," "record," "interrupt recording," "rewind forward," "rewind backward," "slow scan," "fast scan," "playback," "interrupt playback." Both functional and structural circuit diagrams are shown and explained, including sequence of events for control or monitoring action. Conclusion of the article is to follow. Figures 2.

**Digital Frequency Indicator for Radio Receiver Tuning**

*18600045b Moscow RADIO in Russian  
No 9, Sep 88 pp 42-45*

[Article by I. Lazer, G. Braylovskiy, and O. Ostapenko, Leningrad]

[Abstract] A digital frequency indicator for radio receiver tuning is described, digital frequency readout offering the advantages of high precision and suitability for automation of tuning to a preset frequency on both AM and FM sides. The indicator is built with KR1508KhL5 special-purpose integrated microcircuit chips, this series having been designed for synthesizers with high heterodyne frequency stability and being produced by the CMOS technology. It includes KT368A transistors replaceable with any n-p-n silicon device having a higher than 400 MHz cutoff frequency, KT315B/D and KT361B/D transistors replaceable with any preferably silicon devices capable of withstanding a 35 V or higher reverse base-collector voltage, MLT-0.125 resistors, and K10-17-1 capacitors. Figures 5; tables 2; references 4: 3 Russian, 1 Western.

UDC 64.06:621.3.001.1

**New Economic Mechanism and Production of Electrical Consumer Goods**

*18600053a Moscow ELEKTROTEKHNIKA in Russian  
No 9, Sep 88 pp 2-5*

[Article by N. A. Mironova, deputy director, Center of Scientific and Technical Information on Electrical Industry]

[Abstract] The impact of economic "perestroyka" on the electrical consumer goods industry is discussed and analyzed, the trend toward dominance of the market mechanism being recognized as an irreversible one even under given socio-political constraints and expected to close the gap between demand and lagging supply. Reorientation of the industry from a producer's market to a consumer's market is proposed, with appropriate revision of production norms and with inclusion of market research as well as commercial product management in the industry's infrastructure. The mechanics and the effectiveness of such an approach are exemplified by operation of the Baku Air Conditioner Manufacturing Works supplying one particular product to the whole country. The role of government is seen as that of facilitator, financial planner, and supervisor of the economic transformation.

UDC 64.06:621.3

**Innovations in Electrical Consumer Goods**

*18600053b Moscow ELEKTROTEKHNIKA in Russian  
No 9, Sep 88 pp 25-27*

[Article by Yu. K. Semenov, engineer, All-Union Scientific Research Institute of Engineering Aesthetics]

[Abstract] Two problems of innovation are analyzed, to illustrate its broad aspects at scientific, technical, technological, economic, and management levels. The first

problem is converting theoretical knowledge into practical solutions which will facilitate mass production. The second problem is orienting research and engineering efforts toward consumer requirements. The innovation process in the consumer goods industry begins with conception and development of an idea bank. There follows an evaluation by a panel of experts which include not only design and manufacturing engineers but also economists and marketing specialists, whereupon ideas are selected for commercial product development. On the average, only 2 out of 100 inventions are found to be commercially feasible. Among new concepts in the area of electrical consumer goods which as attracted attention and interest is that of dual-purpose appliances: combination freezer and microwave oven, coffee mill and coffee pot, lamp and clock, lamp and fan.

UDC 64.06-192.001.4

**Methods of Optimizing Reliability Control of Electrical Consumer Products**

*18600053c Moscow ELEKTROTEKHNIKA in Russian  
No 9, Sep 88 (manuscript received 3 Dec 87) pp 34-38*

[Article by Ye. A. Sudbin, engineer, Center of Scientific and Technical Information on Electrical Industry]

[Abstract] The new GOvernment STandard 17446-87 covers quality control of electrical consumer products and will remain in force for at least the next five years. The reliability criteria included in this standard are mean time of failure-free operation and mean service life, both being classifiable as group indicators. Optimization of the quality control process in accordance with these reliability criteria in terms of minimum cost of testing is considered, a mathematical model being proposed which facilitates an analytical determination of the optimum sample size and test time. The functional relation between these two variables, graphically describable by a hyperbola, is approximated with sufficient accuracy by a second-degree Lagrange polynomial and then evaluated as such with the aid of tabulated data by the methods of probability calculus. Figure 2; tables 2; references 7: Russian.

UDC 621.313.13.024:688.72

**New Series of Toy Micromotors**

*18600053d Moscow ELEKTROTEKHNIKA in Russian  
No 9, Sep 88 pp 42-44*

[Article by K. A. Alikhanyan, doctor of technical sciences, Yu. K. Arutyunyan, candidate of technical sciences, A. M. Arutyunyan, candidate of technical sciences, and V. K. Sakapetoyan, engineer, Scientific Research Institute of Electrical Machines]

[Abstract] A new series of toy micromotors has been developed, all 16 models having better energy characteristics and a lower noise level than those now produced in the USSR. Their torque ratings cover the 0.5-15.0 N x

mm range and their speed ratings cover the 4000-18,000 rpm range. They are designed for six different voltages: 1.2 V (1 model), 2.4 V (4 models), 3.6 V (6 models), 6.0 V (1 model), 9.0 V (1 model), 12.0 V (3 models). The housings are made of metal rather than cast plastic, which contributes to a smaller motor size and a better overall economy of materials. The magnets are spring-mounted, two segments of oriented hard barium ferrite. The commutator is monolithic, with hooks for terminating the armature coils on the rotor. The brushes are made of beryllium bronze for voltages up to 6.0 V and of copper-graphite for the higher voltages. The rotor runs on two bearings made on molded and impregnated powder-metal bronze. The new micromotors have a higher built-in reliability, for a life expectancy longer than the 15-35 h life of those now on the market. They are designed for automatic assembly and up to 30 pct lower labor content. A special plant is built by the Industrial Association "Armenian Electric Motor" for beginning production of these new micromotors in 1988. Figures 4; tables 3.

UDC 621.397.132.129

**Use of Synchronous Wobulation for Higher Definition of Television Image**

18600064a Moscow *TEKHNIKA KINO I TELEVIDENIYA* in Russian No 10, Oct 88 pp 17-23

[Article by A. A. Maksakov and T. G. Sorokina, Moscow Institute of Electrical Communications Engineering]

[Abstract] A scheme for improving the already high definition of television image and transmitting them over channels of limited width by the method of synchronous wobulation in a combination black-and-white and color television broadcasting system is proposed, this method having already shown to be effective for compressing the frequency band of a television signal so as to make it transmittable over telephone wire pairs and for interleaving independent television messages in a common frequency channel without widening the latter. The electron spot in this scheme has a diameter equal to half the diameter needed for filling the largest image element, and the raster oscillates slightly in the vertical plane. Reduction of flicker without degradation of image quality is achieved by utilizing the information redundancy, statistical or physiological, of television signals and by lengthening the light transit time. The transmitter part of the system consists of an objective, a transmitter tube, a video amplifier, a discretizer, a 4 MHz low-pass filter, a recording head, four sound pickups, an erasing head, video tape, a line scanner, a frame scanner, a high-frequency deflection yoke, a frequency doubler, a synchro transmitter, a 0-90-18-270 deg phase selector, a details comparator, a coincidence circuit, a movements

comparator, and an output stage. The receiver part of the system consists of a high-frequency amplifier, an intermediate-frequency amplifier, a video detector, a video amplifier, a discretizer, a synchro pulse discriminator, a synchronous demodulator, a 4 MHz reference-signal generator, a frequency doubler, a high-frequency deflection yoke, a paraphase amplifier, a transmitter, a line scanner, a frame scanner, and a kinescope built so as to combine the advantages of short-persistence and long-persistence luminophors. Wobble in the transmitter part and in the receiver part can be synchronized by any conventional mechanism. Figures 4; references 5: 3 Russian, 2 Western.

UDC 654.197.004.14:681.322

**Scheduling Television Broadcasts With Aid of Personal Computer**

18600064b Moscow *TEKHNIKA KINO I TELEVIDENIYA* in Russian No 10, Oct 88 pp 39-40

[Article by V. S. Gordon and O. P. Yanova, Institute of Engineering Cybernetics, BSSR Academy of Sciences]

[Abstract] A program package "Ekran" (Screen) has been developed at the Institute of Cybernetics for scheduling weekly television broadcasts with the aid of a personal computer, specifically a YeS 1840 one. With this program package, written in BASIC, a computer can handle requisitions by executing commands: LOAD, CLEAR, TURN PAGE, DIVULGE. The package provides also for corrective operations: DELETE, CHANGE (program title, starting time, program length), INSERT, TRANSPPOSE. The package, with enough flexibility for future expansion, was submitted to the BSSR "GOSTELERADIO" (State Television and Radio Broadcasting System). References 1: Western (in Russian translation).

**New Motion-Picture Cameras: Old Problems Under Present Circumstances**

18600064c Moscow *TEKHNIKA KINO I TELEVIDENIYA* in Russian No 10, Oct 88 pp 78-79

[Interview with V. F. Gordeyev, I. D. Barskiy]

[Abstract] In an interview with this correspondent, V. F. Gordeyev (chief of designer, Moscow Design Office for Motion-Picture Equipment) and I. D. Barskiy (chief engineer, "Moskinap" Moscow Motion-Picture Equipment Manufacturing Plant) discussed the mixture of successes and failures in development, design, and production of motion-picture cameras. They explained the reasons for updating good older models and building new models, depending essentially on the feasibility of adaptation to film makers' requirements with available technology. The problem has obviously not changed, only the circumstances and the state of the art have.

UDC 621.396.674.1.001.24

**Design of Shielded Loop Antenna**

*18600043f Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 46-48*

[Article by L. V. Vasenkov and V. A. Tishchenko]

[Abstract] Design of shielded frame antennas for measuring the magnetic field component of 2 kHz-30 MHz electromagnetic fields is analyzed, important considerations being symmetrization with respect to "ground" and matching with the channel. The electrical parameters of such an antenna are calculated for one with  $k_b$  much less than unity ( $k$ —maximum wave number in free space within operating wave band,  $b$ —radius of antenna), with  $h$  less than  $a$  ( $h$ —half width of gap,  $a$ —radius of shield), and with  $a$  much less than  $b$ . The skin depth at the lowest operating frequency is assumed to be much smaller than the thickness of the shielding conductor. Calculations are based on Kirchoff's current and voltage laws for the equivalent circuit, supplemented by the transmission-line equations for both parallel long coaxial segments. The skin effect is taken into account and inclusion of a corrective capacitance is considered. Figures 2; tables 1; references 6: 4 Russian, 2 Western (1 in Russian translation).

UDC 621.394.5

**Data Transmission Techniques Abroad**

*18600052g Moscow ELEKTROSVYAZ in Russian No 7, Jul 88 (manuscript received 12 Mar 87) pp 51-56*

[Article by V. G. Osipov]

[Abstract] A comparative survey is made of modems, multiplexers, and terminals produced by U.S., British, and French manufacturers for data transmission. Their design and performance are described, modems being classified into single-standard and multistandard ones in terms of CCITT recommendations and conventional telegraph multiplexers being outpaced by statistical ones with time division of channels. Tables 2.

UDC 621.396.679

**Diagnostic Testing of Short-Wave Antennas and Transmitters by Thermographic Method**

*18600052h Moscow ELEKTROSVYAZ in Russian No 7, Jul 88 (manuscript received 5 Feb 87) pp 61-62*

[Article by S. V. Voynov and Ts. I. Tsanev, BULGARIA]

[Abstract] A short-wave transmitter and two antennas, a log-periodic one and a cophased horizontal wideband horn, were diagnostically tested by the thermographic method. Measurements were made outdoors in calm weather at an air temperature of 21 deg C. They were made with infrared-radiation thermometers from a distance much larger than the linear dimension of the object. Analysis and evaluation of the data indicate that periodic

inspection by this method facilitates preventive maintenance and thus contributes to more reliable operation of short-wave radio systems. Figures 1; tables 1; references 4: 2 Bulgarian, 2 Western.

UDC 621.396:629.785:523.42

**Frequency Fluctuations of Decimetric and Centrimetric Radio Waves During Communication With 'Venera-15,16' Probes Through Circumsolar Plasma**

*18600057a Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 8, Aug 88 (manuscript received 29 Dec 86) pp 1574-1583*

[Article by N. A. Armand, A. I. Yefimov, O. I. Yakovlev, V. P. Yakubov, A. S. Vyshlov, A. S. Nabatov, A. S. Kafonov, S. N. Rubtsov, and O. M. Korsak]

[Abstract] An experimental study was made concerning frequency fluctuations of 32 cm and 5 cm radio waves used for communication with "Venera-15,16" probes, these fluctuations occurring during passage of radio waves through the circumsolar plasma and needing to be analyzed for a study of that plasma. Considering that since March 1984 the distance between Earth and Venus exceeds 1 AU so that they find themselves on opposite sides of the Sun, the basic geometrical parameter determining the conditions of radio wave propagation during that period is the smallest distance from the propagation path to the Sun. Measurements were made with the aid of phase-lock automatic frequency control for tracking the frequency of decimetric-wave and centimetric-wave signals. The data, covering the April-August 1984 period, have yielded both time and frequency spectra of frequency fluctuations, a stable radial dispersion of the fluctuation frequency during sunrise and sundown, and information about inhomogeneities in the circumsolar plasma at various heliocentric distances indicating changes in solar activity. For a quantitative description of the frequency fluctuations, the data have been evaluated in terms of three characteristics: r.m.s. value, spectral density, and spectral index of time spectra. Figures 4; tables 4; references 18: 12 Russian, 6 Western.

UDC 621.396.67.01

**Reflector Antennas With Anisotropic Surfaces: Polarization Transformers**

*18600057b Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 8, Aug 88 (manuscript received 14 Oct 86) pp 1590-1599*

[Article by B. Ye. Kinber, E. E. Gasanov, and M. M. Vaynbrand]

[Abstract] Polarization transformation within the range from linear to clockwise or counterclockwise circular by anisotropic surfaces of axisymmetric reflector antennas is analyzed theoretically, following definition of the complex polarization vector in Gaussian coordinates at the fronts of

incident and reflected waves, and formulation of the corresponding reflection matrix. First is considered polarization transformation by means of one reflector, in which case the reflection matrix is diagonal and it is sufficient to fix only three parameters of the anisotropy pattern for transformation of any one polarization into another. This is demonstrated on transformation of a spherical wave from a vertical electric dipole into a plane wave upon reflection by a paraboloid of revolution. Next is considered polarization transformation by means of two reflectors, in which case two surfaces must be anisotropic so that six parameters need to be fixed and some of them may be arbitrarily specified or based on any additional requirements. This is demonstrated on an axisymmetric two-reflector antenna with one array of annular grooves and one array of meridional grooves, the reflection matrix in this case not being diagonal in the basis of the plane of reflection. The authors thank A. V. Shishlov for helpful discussion. Figures 4; tables 2; references 5: 2 Russian, 3 Western.

UDC 537.874.6.01

**Method of Solving Two-Dimensional Problems of Diffraction for Electromagnetic Waves and Ideally Conducting Polygonal Structures**

18600057c Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 8, Aug 88  
(manuscript received 23 Feb 87) pp 1600-1609 [Article by V. P. Chumachenko]

[Abstract] Solving two-dimensional problems of diffraction for electromagnetic waves and ideally conducting cylindrical surfaces with piecewise-rectilinear cross-section contour is considered, it having been proposed to represent the sought component of the electric field parallel to the generatrix of such a surface as the sum of the incident field and the series of N reflected fields (N denoting the number of contour segments) so that the problem reduces to an infinite system of linear algebraic equations. Validity of this method is based on a sufficiently fast convergence of the series, allowing truncation of the infinite system of equations for subsequent solution by the reduction method without causing the solution to become unstable. The algorithm of numerical solution is applied, for illustration, to diffraction of an E-polarized plane wave with unity amplitude by two polygonal model structures: an equilateral dihedral reflector and a cylindrical reflector with isosceles triangular cross-section. The method is further applied to a waveguide-type transformer, namely a waveguide having a rectangular cross-section with a step in the H-plane. Figures 2; tables 4; references 20: 16 Russian, 4 Western (all in Russian translation).

UDC 537.874.6.01

**Wood's Anomalies in Diffraction of Radiation by Metal Structures With Small-Amplitude Corrugation and Finite Conductivity**

18600057d Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 8, Aug 88  
(manuscript received 30 Mar 87) pp 1610-1616

[Article by A. A. Kovalev, P. S. Kondratenko, and B. N. Levinskiy]

[Abstract] Diffraction of electromagnetic waves by peri-

odic metal gratings is analyzed, taking into account Wood's two anomalies of a new diffraction order and of resonantly excited surface electromagnetic waves. The gratings are assumed to be structures with a corrugation amplitude smaller than the wavelength of incident radiation and all perturbation orders with respect to the ratio of corrugation amplitude to radiation wavelength are included in the analysis, considering also that a metal has a finite electrical conductivity. Following a general solution of the corresponding system of two matrix equations in the Rayleigh scattering approximation for a monochromatic plane incident wave and the Leontovich boundary condition, approximate analytical solutions are obtained for two model grating structures: a sinusoidal grating with characteristically fast convergence of the infinite series and an echelette grating with characteristically slow convergence of the infinite series. In the latter case, specifically for an echelette with a rectangular profile, a physically valid artifice is devised which allows truncation of infinite series and thus facilitates solution of the diffraction problem. The authors thank B. Ye. Kinber for discussing pertinent points. Figures 1; references 13: 7 Russian, 6 Western (1 in Russian translation).

UDC 621.396.62

**Separation of Signals and Interference in Search of Cosmic Radio Emission With Drifting Frequency**

18600057e Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 8, Aug 88  
(manuscript received 17 Jun 86) pp 1658-1664

[Article by Yu. M. Bruk, O. M. Ulyanov, and B. Yu. Ustimenko (deceased)]

[Abstract] The problem of detecting radio emission signals from pulsars is considered, such signals usually being characterized by a frequency drift according to a known or unknown law and being mixed with nondrifting wideband interference and additive noise. Detection of such signals through N channels tuned to different frequencies reduces the problem to determination of unknown functions from known sums of these functions. The problem is solved by the method of least squares, signals and interference in different channels being assumed to differ only in the cyclic shift and their respective scale factors. A linear algorithm of this method minimizing the mean-square error of a pseudo-solution is devised for the case where all three scale factors (signal, interference, noise) are equal to unity. A correlation algorithm is constructed for the case of an interference much stronger than the signals. The latter algorithm has been found to be very effective for detection of radio emission signals from the 1919 plus 21 pulsar with the DKR-1000 radio telescope in the Radio Astronomical Observatory at the Institute of Physics (USSR Academy of Sciences). This radio telescope operated with 56 simultaneously active channels in the 40 MHz frequency band, accumulating 800 pulses per cycle with a channel separation of 0.82 and a longitude resolution of 32. Figures 3; tables 2; references 2: 1 Russian, 1 Western.

UDC 656.259.2:621.317

**Apparatus for Checking Automatic Locomotive Signalization**

*18600041a Moscow AVTOMATIKA TELEMEKHANIKA I SVYAZ in Russian No 8, Aug 88 pp 11-14*

[Article by D. N. Khromushkin, chief designer, V. V. Glushko, master designer, and O. N. Kolyada, engineer, All-Union Scientific Research Institute of Railroad Transportation Automation]

[Abstract] A standard apparatus for checking and testing automatic locomotive signalization has been developed which can be adapted to six modes of operation, with nonmodulated 25-83 Hz and 125-375 Hz signals including smooth current regulation over the 0.5-5 A range or with phase-shift keyed 175 Hz and 0.05-2 A signals. The apparatus consists of a switching device activated directly or through a programming device from the local-control panel or from the remote-control panel, followed successively by an encoder, an amplifier, a harmonic filter, a matching device, and a set of test loops. The programming device includes a master oscillator with an inverter output stage on four microcircuit chips, a counter on three microcircuit chips, a programmable read-only memory on one microcircuit chip, and a buffer stage on two microcircuit chips which feeds light-emitting diodes in altogether eight indicator channels, relays being controlled by pairs of plain and light-activated diodes. Any program can be interrupted at any step when necessary, a "stop" switch and a "stop" relay being provided in the control panels. Figures 4.

UDC 656.25:621.317.39:531.76

**Modified Radar Instrument for Measuring Speed of Uncoupled Cars**

*18600041c Moscow AVTOMATIKA TELEMEKHANIKA I SVYAZ in Russian No 8, Aug 88 pp 8-10*

[Article by V. I. Shelukhin, candidate of technical sciences, N. N. Kolesnichenko, engineer, and V. G. Pyzhyanov, engineer]

[Abstract] The third modification of the RIS-V2 radar instrument with a Doppler-signal converter for measuring the speed of uncoupled cars in hump yards such as those at Krasnyy Liman and Bataysk railroad stations is described, higher immunity to fluctuations of incoming echo signals and higher stability of the converter during

their fadeout having been built in by addition of phase-lock automatic frequency control. The instrument includes a microwave oscillator and a microwave transceiver horn antenna with an active low-pass filter in the receiver channel, as before, but has now two comparators instead of one. The second comparator feeds the frequency discriminator in the phase-lock automatic frequency control, while the first one feeds a shaper of strobing pulses directly and through a peak detector. The phase-lock automatic frequency control is based essentially on the standard scheme, which includes a summing device, a controlled integrator, a voltage-to-current converter, a voltage-controlled oscillator, and a frequency divider. Signals from the frequency divider are shaped into control pulses for the shaper of strobing pulses. The output stage of the instrument consists of a pulse-to-voltage converter followed by a scale converter. The pulse-to-voltage converter receives strobing pulses and control pulses, the latter through a shaper of calibrated countable pulses, it also operates as a memory in the absence of an input signal over a period of time estimated at 2 s. Figures 2.

UDC 621.396.96

**Characteristics of Short-Pulse Radar for Locating Buried Objects**

*18600057i Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 8, Aug 88 (manuscript received 18 Sep 87) pp 1776-1779*

[Article by V. I. Barantsov]

[Abstract] The performance of a wideband short-pulse radar is analyzed for design purposes, such a radar being effectively used for locating buried rocks and other objects. An essential consideration is the frequency dependence of the electrical properties of the medium through which sounding and echo signals propagate. Dispersion of the electrical properties of wet rocks, for instance, is associated not only with the conduction current but also with polarization relaxation of charges in pores at lower frequencies and dipole relaxation of water molecules at higher frequencies. The frequency dependence of the dielectric permittivity and the electrical conductivity, also of the loss tangent, are calculated theoretically on the basis of the Debye-Langevin equation. For the important practical application of such a radar, namely location of firm inclusions in soft enclosing coal or other rock masses, the pulseform of an echo signal is calculated and shown to depend on the embedment depth of the reflecting target. Figures 2; references 4: 2 Russian, 2 Western (1 in Russian translation).

UDC 621.3.049.75:681.2

**Problems in Instrument Design With Microelectronics**

*18600046a Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 8, Aug 88 pp 1-3*

[Article by S. A. Belousov]

[Abstract] Microminiaturization of measuring and control instruments on a firm microelectronic base has been officially recognized as an important factor contributing to scientific and engineering progress, improvement and novelty being defined in practical terms of technical and economic indicators. The main and most difficult problem in implementation of instrument design with microelectronics and maximum circuit integration is the problem of retooling the instrument manufacturing industry, not only the individual production enterprises but the entire industrial sector including supportive enterprises. This will require broad planning and extensive reorganization as well as substantial capital investment. References 2: Russian.

UDC 681.3.066.004.1

**Interactive Monitor-Adjustor for Development of Systems on Basis of Series K580 Microprocessor Array**

*18600046b Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 8, Aug 88 pp 12-13*

[Article by E. L. Romin, engineer, and R. B. Fridlyand, engineer]

[Abstract] An interactive 1800-Minicomputer terminal with keyboard and display can be used as monitor-adjustor for development of automatic control systems on the basis of series K580 microprocessor arrays capable of high-speed real-time operation. A program written in PL/M language covers syntactic and semantic analysis of the 11 relevant commands as well as their breakdown into elementary operations, the syntax being identical to that of a MONID 1800-Minicomputer monitor-adjustor. The monitor uses 9 digital inputs and 10 digital outputs. It does not require a high-speed transmission channel, 180-300 bauds being adequate for the given application. Such a monitor has been designed and built for a UTsM-100 control device, with a 30-byte direct-access memory including a 6-byte monitor stack and a 548-byte read-only memory for the monitor codes. Figures 2.

UDC 621.3.087.9

**Criteria for Evaluation of Printers Used with Personal Computers**

*18600046c Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 8, Aug 88 pp 15-16*

[Article by O. P. Arkhipov, engineer, and O. T. Khodyrev, engineer]

[Abstract] Considering that the software of basic printers for personal computers is subject to international standards and thus practically identical for all printers available on the market, several criteria are proposed for their

design and performance evaluation from the user's standpoint. The first criterion is the specific capacity, namely product of printing speed (symbols per second) and maximum number of 2.54 mm long strokes in a line per gram of printer mass. The second criterion is the efficiency, defined as printing speed per watt of input power. The third criterion is the print quality, defined as product of character contrast ratio relative to optimum attainable 0.7 and character shape reproducibility factor. A comparative evaluation of 22 printers put on the market by 8 manufacturers (Mannesman-Tally, Brother, Centronics, Data-south, Okidata, Star, Epson, Genicom) over the 1980-86 period includes projections to the year 1990. Figures 3; tables 2; references 3: 2 Russian, 1 Western.

UDC 621.398

**Correction of Output Signals from Frequency Transducers by Method of Frequency-To-Code Conversions**

*18600046f Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 8, Aug 88 pp 26-27*

[Article by P. T. Kharitonov, candidate of technical sciences]

[Abstract] The method of frequency-to-code conversions is applied to digital frequency transducers for correction of their output signals and direct real-time readout. The frequency of output signals is converted into the code of a programmable read-only memory which stores binary-decimal codes of the measured quantity, temperature and pressure being typical such quantities. This particular application of the method requires unique ways and means of checking, all taken into account in the development work done by the Department of Automation and Computer Engineering at the Penza Polytechnic Institute. Figures 2; references 6: Russian (Patents).

UDC 621.3.061:621.865.8.002.1

**Robotized Preparation of Radio Components for Assembly**

*18600046g Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 8, Aug 88 pp 36-37*

[Article by Ya. M. Altman, engineer, B. I. Gorn, engineer, and V. A. Kobets, engineer]

[Abstract] Several new production complexes on the basis of PR-5-2P.5.4.3. industrial robots, VP-160 vibrator drives, and P-B1-16/20 pneumatics have been installed in the "Elektronmash" (Electronic Machinery) plant in Chernovtsy, their task being to prepare radio components with unidirectionally oriented lead wires for assembly. The principal components of such a complex are mounted on the table which covers a welded-construction chassis. Its advantages over analogous existing RKV, RKT, and RKM-P robotized complexes are smaller size and lower power requirement. Figures 1; references 2: Russian.

UDC 53.089.68:621.317.772

**Reference Apparatus for Measuring Attenuation and Phase Shift of Signals in 2-3 mm Wave Bands**

*18600043c Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 41-43*

[Article by V. A. Golba, A. V. Kistovich, and T. Ya. Zhdanova]

[Abstract] A reference apparatus for measuring the attenuation and the phase shift of microwave signals in 2-3 mm wave bands is described which operates with a single-oscillator heterodyne instrument. As reference intermediate frequency has been selected 74 Hz, corresponding to the speed of the rotor in the phase shifter and thus independent of the microwave oscillator frequency. The oscillator signal passes through a horn-lens transition with a matching input transformer, whereupon an energy flux splitter divides it into two channels: measuring channel and heterodyning channel. The signal is rotated by a mirror and its frequency is shifted by a continuous-duty quasi-optical phase shifter. The losses in this channel are minimal, but "parasitic" couplings in it are correspondingly many. Imperfect setting of the phase shifter and its load dependence as well as instability of the microwave signal and limited matchability of the microwave components make it necessary to tune this channel prior to measurements. It is also necessary to tune the waveguide-type reflectometer in this channel and the balanced bolometric mixer in the heterodyning channel. The apparatus was tested for its systematic errors as well as for random errors of measurement. The systematic error due to mismatch of components can be calculated and the appropriate correction can be made, moreover, on the basis of measurable complex reflection coefficients. The apparatus is intended for certification of attenuation standards covering the 0-60 dB range, its error not exceeding 0.4 dB at the top of the scale and 0.03 dB at the bottom of the scale. It measures phase shifts covering the entire 0-360 deg range, the error of a measured differential phase shift not exceeding 0.3 deg anywhere within that range. Figures 2; references 7: Russian.

UDC 621.317.757.089.6:621.372.6

**Method of Calibrating Automatic Microwave Circuit Analyzers With 12-Pole Reflectometers**  
*18600043d Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 43-45*

[Article by S. M. Nikulin and A. N. Salov]

[Abstract] A universal method of calibrating 12-pole 4-arm reflectometers in automatic microwave circuit analyzers is proposed, on the basis of a model of such reflectometer which relates the power recorded in each arm to the complex amplitudes of the waves incident on and reflected by the load. The power in each arm is,

according to this model, equal to the square of the absolute sum of those two complex amplitudes multiplied each by a complex constant characterizing the reflectometer design. This relation applicable to any of the four arms is transformed into a system of four linear homogeneous calibration equations solvable by the method of least squares and yielding the power division between arms. The reflectometer constants can be calculated only in terms of maximum-likelihood estimates, by minimizing the "power measurement error" functional. An analyzer can be thus calibrated for measurement of the complex reflection coefficient at 2-4 GHz frequencies with an error of its modulus not exceeding 0.005 and an error of its phase not exceeding 0.3 deg divided by the modulus. Figures 1; references 5: 1 Russian, 4 Western.

UDC 621.373.121.14.029.64

**Stable Microwave Oscillators With High-Q Cavity Resonators**

*18600057f Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 8, Aug 88 (manuscript received 10 Nov 86) pp 1696-1705*

[Article by I. I. Minakova and V. I. Panov]

[Abstract] Frequency stabilization of multistage microwave oscillators by means of high-Q superconducting or dielectric cavity resonators is considered from both theoretical and experimental standpoints. The performance characteristics of such a system are evaluated algebraically on the basis of the system of differential equations describing one-frequency oscillations and analysis of its solution, the number of equations being equal to the number of oscillator stages and thus corresponding to the number of degrees of freedom. A three-stage oscillator being most typical, natural frequency fluctuations in such an oscillator with correspondingly three degrees of freedom are analyzed for frequency stability. An experimental study was made using nominally 3.0 GHz - 0.1 W reflex-klystron oscillators ( $Q_1$  approximately 3000,  $Q_2$  close to 250) stabilized by superconductor-on-sapphire cavity resonators ( $Q_3$  equal to  $4 \cdot 10^8$ ), nominally 2.9 GHz - 2mW sapphire tunnel-diode oscillators (hollow first cavity resonator, silver-coated intermediate second cavity resonator having  $Q_2$  close to 100) stabilized by Nb or Pb superconducting films ( $Q_3$  variable from  $2 \cdot 10^7$  to  $2 \cdot 10^8$ ), and nominally 3.0 or 10 GHz - 25 mW Gunn-diode oscillators ( $Q_2$  close to 100) stabilized by dielectric (sapphire) disk or ring cavity resonators ( $Q_3$  variable from  $1.5 \cdot 10^5$  to  $2 \cdot 10^5$  at 300 K temperature and from  $0.6 \cdot 10^7$  to  $4 \cdot 10^7$  at 77 K temperature). Measurements have yielded not only frequency but also amplitude fluctuation spectra, an analysis of these spectra revealing a dependence of the relative frequency instability on the length of averaging time and thus indicating the stability limit of such oscillators. Figures 6; references 18: 15 Russian, 3 Western.

UDC 621.396:778.38

**Reconstruction of Images of Objects From  
One-Dimensional Radioholograms Synthesized at  
Low Diffraction Angles**

18600057g Moscow RADIOTEKHNIKA I  
*ELEKTRONIKA* in Russian Vol 33 No 8, Aug 88  
(manuscript received 31 Mar 86) pp 1747-1756

[Article by V. V. Chapurskiy]

[Abstract] Synthesis of one-dimensional diffraction radioholograms in the time domain for reconstruction of images of large moving objects is described and the information content of such radioholograms is evaluated in the approximation of physical optics, specifically in the Fraunhofer approximation corresponding to low

diffraction angles, and in accordance with Babinet's principle making diffraction of a field by an opaque shield equivalent to diffraction by an infinitely large supplementary shield with a hole which circumscribes the shadow of the object. Following establishment of the conditions for image reconstruction, the characteristics of a low-angle diffraction radiohologram synthesized by inversion are identified and the algorithm of such an image reconstruction is formulated. The resolution of such a radiohologram along the object's trajectory is found to be determined by the ratio of radiation wavelength to width of the sector within which either the aspect of the object's shadow or the horizontal diffraction angle changes during the observation period and to thus be improved by lengthening of the observation time. Figures 4; references 7: 5 Russian, 2 Western (1 in Russian translation).

**Distributed Information Search System for '09' Service in Urban and Rural Telephone Networks**  
*18600044a Moscow VESTNIK SVYAZI in Russian*  
*No 9, Sep 88 pp 26-30*

[Article by R. P. Shertvitis, department head, P. Yu. Skinkis, chief project engineer, G. E. Vebra, senior engineer-programmer, M. I. Chizhyuvene, senior engineer-programmer, and B. G. Kvetkauskayte, senior engineer-programmer, Regional Information and Computation Center, LiSSR Ministry of Communications]

[Abstract] The distributed automatic telephone directory management system APS-09 for urban and rural telephone networks provides information service to residential and institutional customers, this service including entry of new numbers and number changes. The system uses two computers at the center, one for search plus correction and one for search only, each with a read-only memory and a larger external memory on magnetic disks. The capacity of each memory and the number of video terminals in '09' service department, subscriber department, and editor's department depend on the size of the network. Any computers such as SM-4/1140/1300.1/1600/1700 minicomputers or Elektronika MS-1211 microcomputers controlled by or compatible with a real-time operating system are suitable for access to the APS-09 system. The distributed structure of this system is shown diagrammatically. Its operation is demonstrated on a long-distance directory search and on a local directory search within an institution such as a childrens' hospital complex. The system has been installed in Vilnius, will be installed in other cities within the Lithuanian SSR, and has been recommended for installation in cities throughout the USSR. Figures 3; tables 5.

**Single-Cable Operation in K-1020 S Transmission System**

*18600044b Moscow VESTNIK SVYAZI in Russian*  
*No 9, Sep 88 pp 36-38*

[Article by I. P. Lesevoy, senior engineer, and V. Ye. Belenkiy, head of production laboratory, Engineering and Production Department TPO-2]

[Abstract] The feasibility of organizing a communication link over up to 480 channels of a two-band four-wire single-cable line in a K-1020 S transmission system is demonstrated theoretically with support of numerical data, such a link being needed for temporary communication between two attended repeater stations when a fault occurs or is being cleared and when routine or preventive inspection is done along a line segment between two unattended repeater stations within the zone covered by the attended ones. Analysis of the problem and calculations are based on the equivalent circuit, on the frequency characteristic of crosstalk, and on the relation of the latter to the stability margin. Use of

filters and decouplers is considered, their proper connections being shown, and reduction of the number of channels for maximum adaptability to standard equipment is recommended. Figures 6; tables 1.

**New Service: Long-Distance Conversation at Averaged Rate**

*18600044c Moscow VESTNIK SVYAZI in Russian*  
*No 9, Sep 88 pp 51-52*

[Article by I. P. Maslenkova, VESTNIK SVYAZI correspondent, interviewing V. I. Fedorov, director 'Moscow Metropolitan Telephone Service']

[Abstract] The interviewee explains how telephone calls from coin booths are made, how the coin deposition and collection system works, and what modifications will have to be made to adapt local-call coin booth equipment for long-distance calls. Handling such calls will require reducing the time limit per call from three minutes to one and computing the charge. He also discusses the economics of the changeover and the economics of rate setting, all based on telephone traffic statistics and key averages.

**Various Schemes for Use of AMT-69/15 Automatic Long-Distance Telephone Coin Boxes for Interurban Communication**

*18600044d Moscow VESTNIK SVYAZI in Russian*  
*No 9, Sep 88 pp 55-59*

[Article by B. K. Klibaner, candidate of technical sciences, chief engineer, Production-Engineering Management of Yalta Municipal Communication Network]

[Abstract] Five different schemes for use of the AMT-69/15 automatic long-distance telephone coin boxes are described, these coin boxes having been widely installed in Yalta for the convenience of the local population as well as of guests and vacationers wishing to call anywhere within the USSR. Two schemes are designed for manual charge computation by the operator, one without and one with an "answer" button. Two schemes are designed for automatic charge computation, one without and one with an "answer" button. The fifth scheme is designed for charge computation with an "answer" button and with thyristor control. Analysis of the telephone traffic expansion and the corresponding revenue growth over the 1980-87 period indicates that the AMT-69/15 coin boxes are still indispensable, but that service will deteriorate unless they are replaced with new better ones. One ought to rule out the TMSN-150G coin box proposed by the USSR Ministry of Communication Equipment Manufacturing Industry, inasmuch as it is inferior and requires a 220 V supply. Figures 6; tables 1.

UDC 621.396.22.029.7:658.012.011.56

**Hardware Complex for Fiber-Optic Communication Networks in Distributed Process-Control Systems**

*18600046d Moscow PRIBORY I SISTEMY UPRAVLENIYA* in Russian No 8, Aug 88 pp 18-19

[Article by V. A. Petrenko, candidate of technical sciences, N. B. Glukhova, engineer, Yu. S. Sykov, engineer, and L. I. Talalay, engineer]

[Abstract] A hardware complex has been developed by the Scientific-Industrial Association "Promavtomatika" (Industrial Automation) according to the "Euromechanics" standard for building integrated fiber-optic communication networks for distributed process-control systems, among them networks which can be connected to control computers or to interactive port terminals. The structure of this complex is illustrated on a network with two dispatchers, two types of stations, and a repeater, the type-A stations connecting the network to control computers and the type-B stations connecting it to terminals. The network is designed to allow hardware interaction beyond program and interface compatibility, its basic structure being a double ring for two-way communication. The hardware is based on series K580, K555, K561 microcircuit chips. The simplest transceiver for interaction of terminals and control processor is an Elektronika MS4101, which consists of a transmitter-converter and a receiver-converter connected through a fiber-optic channel. Data can be processed either in the repeater mode without conversion to a position code or in the multiplexer mode with conversion to a position code in the receivers. In the latter mode a standard Elektronika MS4101 can operate at a speed of 8 MBit/s. Data are processed from TTL input levels to TTL output levels, synchronization and reliability check reducing the throughput to 80,000 words per second. An outstanding feature of a distributed process-control system based on this hardware complex with access to up to 256 data input/output ports is simplicity of the communication protocol, of the driver programs, and of the automatic diagnosis. Figures 2; references 2: Russian.

UDC 621.317.714.182.6(088.8)

**Static Characteristic of Inductive High-Current Transducers**

*18600046e Moscow PRIBORY I SISTEMY UPRAVLENIYA* in Russian No 8, Aug 88 pp 25-26

[Article by A. M. Plakhtiyev, candidate of technical sciences]

[Abstract] The static characteristic of inductive high-current transducers is analyzed, such a contactless transducer having been developed at the Tashkent Polytechnic Institute imeni A. R. Beruni for conversion of large currents flowing in the contact plates of self-baking electrodes in ore smelting furnaces of the Chimkent phosphorus production

plant. The analysis is based on the system of three differential equations for the rates of change of the two magnetic fluxes and of the magnetic potential difference respectively, taking into account the longitudinal distribution of parameters and flux crowding as well as nonlinearity of the fundamental magnetization curve for a structure including a core made of 3413 electrical-grade steel. The results of theoretical calculations agree within 5 pct with experimental data. Figures 2.

UDC 621.39

**Development Trends in Electrical Communications, Part 2: Technology and Transmission Systems**

*18600052a Moscow ELEKTROSVYAZ* in Russian No 7, Jul 88 pp 7-13

[Article by G. G. Kudryavtsev and L. Ye. Varakin]

[Abstract] Current developments and achievements in electrical communications worldwide reveal certain key trends, evidence of which was given at the Telecom-87 Exposition and attendant Forum-87 conferences. The main target areas include an Intelligent Network, an Access Network, an Integrated-Service Digital Network, a Network Operation and Management System, and satellite communication networks. Achievements in other areas include cellular portable communication equipment, video teleconference systems, speech codecs, and automatic speech translators. Appearance of fifth-generation computers and application of new technologies, particularly those pertaining to lasers, fiber optics, and super-large-scale circuit integration, are largely responsible for the successful solution of design and development problems. On the basis of data already available, some projections are made for the next decade with regard to electrical communications in terms of cost, equipment size, operating range, design, and performance. Figures 13; tables 3; references 36: Western.

UDC 621.315.2

**Peculiarities of and Experience in Installation of Fiber-Optic Communication Lines for Long-Distance Networks**

*18600052b Moscow ELEKTROSVYAZ* in Russian No 7, Jul 88 (manuscript received 9 Mar 88) pp 20-24

[Article by A. K. Belenko, A. I. Kaplan, V. S. Rombo, and V. M. Khabibulin]

[Abstract] Installation of a 117 km long fiber-optic communication line between Leningrad and Sosnovy Bor was completed in 1987. Four different cable configurations had been developed for this line, to match specific terrain conditions, the topography, and soil characteristics. All cables are built with graded-index fibers, four per cable, the attenuation coefficient not exceeding 1.0 dB/km for 1,300 nm radiation. Different core sizes and core constructions, modular or sectional, with protective metal sheaths

or other protective means are found in various segments of the line, in accordance with four technical criteria: low resistance to tension, inability to withstand higher than atmospheric pressure, continuity considerations, and effect of splices on performance characteristics. The installation process was preceded by terrain preparation and incoming cable inspection. The installation itself involved laying the cable segments, assembly of split connecting sleeves, and welding together the cable segments end-to-end. The installation process was followed by acceptance tests and comprehensive measurements extending through the first winter period. Figures 4; references 3: Russian.

UDC 621.395.61

**Interrelation Between Errors in Digital Channel and Fidelity of Discrete-Data Transmission Over Audio-Frequency Channels of Digital Communication Systems**

18600052d Moscow ELEKTROSVYAZ in Russian  
No 7, Jul 88 pp 32-35

[Article by B. A. Medovar]

[Abstract] Transmission of discrete data over audio-frequency channels of digital communication systems is analyzed for interrelation between errors in the digital channel, single errors or error packets, and transmission fidelity. Theoretical calculations are supplemented with experimental data, measurements having been made with two types of data transmission apparatus. In the experiment with an audio-frequency telegraph a group signal with a power of 0.032 mW was frequency-modulated at a rate of 0.2 kbit/s. In the experiment with DUMKA apparatus a signal with the same power was transmitted at a rate of 9.6 kbit/s, either amplitude-modulated and once phase-modulated with partial suppression of one sideband or with combined amplitude and phase modulation according to CCITT recommendations. The results indicate heavy distortion of the analog signal, especially by error packets in the digital channel, transmission of a frequency-modulated signal being most vulnerable. They also reveal a dependence of the maximum allowable number of error packets per transmission run on their time distribution and their content over the same period. The author thanks G. A. Lakhtman, Zh. A. Rechkina, I. M. Levin, V. M. Nechayev, Sh. M. Evyan, A. L. Vinokurova, T. B. Sirkis, Ye. V. Shishkina, and Yu. N. Kulakova for assisting in the experiments. Figures 3; references 10: 3 Russian, 7 Western (6 CCITT).

UDC 621.311.6

**Possibilities of Lengthening Feeder Segments Carrying Power From Remote Supplies to V-60E and K-60P Equipment**

18600052e Moscow ELEKTROSVYAZ in Russian  
No 7, Jul 88 p 40

[Article by V. M. Osipchuk; annotation of article No 1355-sv deposited at the Central Scientific Research Institute 'Informsvyaz', 12 pp with 2 figures and 6 bibliographical references]

[Abstract] Organization of feeders carrying power from remote supplies to V-60E and K-60P line equipment is

analyzed from the standpoint of economy, the aim being to lengthen the feeder segments without degradation of their interference immunity and load characteristics. The analysis is based on thorough measurements involving phantom amplifiers and remote-control circuitry.

UDC 621.394.42:621.391.23.037.372

**Statistical Multiplexer-Demultiplexer SMM-120**

18600052f Moscow ELEKTROSVYAZ in Russian  
No 7, Jul 88 (manuscript received 1 Jul 87) pp 41-44

[Article by B. V. Korop, Ye. M. Gromov, N. A. Spektor, N. M. Zaryanova, L. P. Berenshteyn, and Yu. M. Matys]

[Abstract] A muldex is described which operates with statistical time division of channels, this SMM-120 muldex having been designed for telegraph networks serving up to 120 subscribers. It includes start-stop regeneration of code-dependent signals and synchronous pulse conversion of code-independent signals, also conversion from processing group speed to channel speed on the transmitter side and conversion from channel speed to processing group speed on the receiver side. Group signals are converted and transmitted at a rate of 2.4 kbit/s. The apparatus is built with series 564 integrated-microcircuit chips. Its performance can be monitored through a special control module and satisfies CCITT R.105 recommendations. Figures 3; table 1; references 7: Russian (1 CCITT).

**Automatic Operational Inspection of Radio Relay System**

18600054a Moscow VESTNIK SVYAZI in Russian  
No 10, Oct 88 pp 25-30

[Article by A. G. Uryev, chief of service, and G. Ye. Itkis, senior engineer, Industrial Association 'Main Control Center for Long-Distance Communications']

[Abstract] An automatic system for operational inspection of radio relay systems has been developed by specialists at the Main Control Center for Long-Distance Communications and at the Main Computation Center for the USSR Ministry of Communications, its function being to measure the performance parameters of a radio relay system and of its components during start-up as well as during operation. Its novel feature is remote measurement for real-time analysis of changes in the system. It includes a multichannel discrete monitor with signal switching and TTL comparator output, a multichannel measuring complex, control and synchronization, and a computer complex. Measurements involve conversion of analog signal into digital form, which occurs by first-stage switching, amplification, second-stage switching, polarity reversal of negative signals, pulse-width modulation converting voltage to time interval, third-stage switching with multiplexing, and conversion from pulse-width modulation to digital code. The computer complex consists of an Elektronika-60 microcomputer with a 50-kbyte memory, a 15IEOO-013 display, a storage on Elektronika-GMD-70 magnetic disks, and a DZM-180 printer. The sequence of

interrogations of measurement instruments along the radio relay system including the power supply is determined by the criticality of its components. The data exchange between instruments and minicomputer is effected through an interface operating in a 16-digit code. Provisions are made for self-check of the automatic inspection system. Figures 5; tables 1.

**Statistical Telegraph Multiplexer With Modem SMM-120**

*18600054b Moscow VESTNIK SVYAZI in Russian  
No 10, Oct 88 pp 33-36*

[Article by Ye. M. Gromov, chief of laboratory, Yu. P. Prakhomov, chief of laboratory, and N. A. Spektor, senior scientific associate, Central Scientific Research Institute of Communications, Kiev branch]

[Abstract] A statistical multiplexer with modem for telegraph networks serving up to 120 subscribers is described, this SMM-120 device operating with time division of channels. It transmits, at a rate of 50 baud over 45 channels, a group flux of 2.4 kbit/s per audio-frequency channel between two stations. For lease can be made available 50, 100, and 200 baud code-dependent channels, 50, 100, 200 baud code-independent channels, and 200 baud synchronous start-stop channels connecting remote subscribers of a PD-200 network to the reference station. While a conventional PTS-K telegraph switching substation with channel equipment draws a power of 5.5 kW, the much faster and more reliable SMM-120 multiplexer draws only 80 W. Figures 1; tables 1.

**Protection of Cables Against Landslides**

*18600054c Moscow VESTNIK SVYAZI in Russian  
No 10, Oct 88 pp 36-38*

[Article by I. F. Lyakhovich, senior scientific associate, S. M. Rak, chief of laboratory, and A. Ye. Kvashuk, senior engineer, Central Scientific Research Institute of Communications, Kiev branch]

[Abstract] Protection of underground communication cables against landslides is discussed in terms of preventive countermeasures, which depend on the causes of landslide: 1) increase of stresses on the soil, 2) action of subterranean water, 3) atmospheric precipitation, 4) weathering, 5) construction work, 6) combination of any of these causes. Proper implementation of countermeasures, which range from ground leveling and drainage to turfing and fencing, should reduce the probability of cable damage by 40-80 pct. Tables 1.

**New Technological Processes for Manufacture of Printed-Circuit Boards**

*18600054d Moscow VESTNIK SVYAZI in Russian  
No 10, Oct 88 pp 38-40*

[Article by V. S. Demenkov, department head, and V. M. Yeskov, sector head, Design and Manufacturing Engineering Office, Minsk branch, USSR Ministry of Communications]

[Abstract] A new way of producing printed-circuit boards by most advance methods ensuring a higher than before product quality and especially a more reliable metallization has been implemented at the Kiev "Promsvyaz" (Communications Industry) Plant, namely integration and automation of the following sequence of positive technological processes: cutting out blanks - punching holes - drilling - chemical and mechanical cleaning of outside surfaces - hydroabrasion treatment and subsequent ultrasonic treatment of inside surfaces - chemical copper coating - galvanic buildup of copper layer - deposition of mask on blank spaces - galvanic copper cladding - galvanic tin-lead coating - removal of mask - etching away copper from blank spaces - flashing off mask residue. Galvanic copper coating and cladding is preferably done using acidic sulfate electrolytes with luster-forming additive. On the basis of its excellent performance, this new technology will be installed at the other PCB manufacturing plants (Minsk, Novosibirsk, Sverdlovsk, Yerevan, Odessa).

UDC 621.382

**Effect of Charge Processes in Semiinsulating Substrate on Operation of GaAs Field-Effect Transistor with Schottky-Diode Gate**  
*18600049a Moscow MIKROELEKTRONIKA in Russian Vol 17 No 5, Sep-Oct 88 (manuscript received 6 Jul 87) pp 395-398*

[Article by N. A. Bannov, K. A. Valiyev, and G. Yu. Khrenov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] The operation of a GaAs field-effect transistor with Schottky-diode gate on a semiinsulating substrate for high-speed microwave integrated-circuit electronics is analyzed, considering that the substrate for the epitaxial GaAs layer is a semiconductor overcompensated with acceptors. The model for mathematical simulation takes accordingly into account nonequilibrium of the semiconductor plasma owing to capture and accumulation of electrons from the transistor channel by deep acceptors in the substrate, with attendant redistribution of the potential. The corresponding equations of kinetics, one for each valley within the conduction band, are formulated in terms of one-particle functions characterizing electron distributions with respect to momentum, position, and time. The trap occupation level, also a function of position and time, is a key parameter here dependent on the lattice temperature as well as on the charge carrier concentration and energy distribution. In a p-type substrate such as one doped with Fe it is permissible to assume a Boltzmann space distribution of hole concentration. The results of numerical solution indicate that the substrate influences appreciably not only the internal characteristics of such a device but also its electrical performance characteristics. The authors thank A. I. Lykachchenko for valuable information and R. A. Suris for helpful discussion. Figures 1; tables 1; references 9: 5 Russian, 4 Western.

UDC 621.382

**Intervalley Processes in n-GaAs Field-Effect Transistors**  
*18600049b Moscow MIKROELEKTRONIKA in Russian Vol 17 No 5, Sep-Oct 88 (manuscript received 10 Aug 87) pp 417-420*

[Article by S. Kershulis and A. Reklaitis, Institute of Semiconductor Physics, LiSSR Academy of Sciences]

[Abstract] Intervalley processes in an n-GaAs field-effect transistor with short channel and Schottky barrier is analyzed on the basis of two models, one with a weak Gamma-L coupling and one with a strong Gamma-L coupling. The method of two-dimensional large particles is used for simulation of electronic processes and subsequent solution, by the Monte Carlo method, of both Boltzmann and Poisson equations according to each model. While the Boltzmann equation of kinetics of

electron distribution with respect to position and momentum is solved in the three-dimensional momentum space, the Poisson equation for the potential of a self-consistent field is solved in the two-dimensional real space. The charge distribution over both L and X valleys as well as the current-voltage characteristic of the transistor are found to be different according to each model, in a channel of submicron length quasi-ballistic motion of charge carriers their concentration having a higher peak in the L-valley and a lower peak in the X-valley according to the strong-coupling model than according to the weak-coupling model and the current being somewhat lower over the entire voltage range according to the strong-coupling model. These differences are found to decrease with increasing channel length and to vanish already in a 0.001 mm long channel. Figures 6; references 13: 3 Russian, 10 Western.

UDC 621.3.049.771.14.019.3

**Realization of Multiple Processing Systems with Superchips and Super-Large-Scale Integrated-Circuit Wafers**

*18600049c Moscow MIKROELEKTRONIKA in Russian Vol 17 No 5, Sep-Oct 88 (manuscript received 13 May 87) pp 432-438*

[Article by B. G. Konoplev, Taganrog Institute of Radio Engineering]

[Abstract] Realization of multiple processing systems with programmable architecture containing more than  $10^6$  transistors on superchips and SLSI wafers is considered, this being feasible only with built-in redundancy. Connecting elements can be polysilicon and metal jumpers, metal-to-metal junctions with fused inter-level dielectric, and air gaps between metallized conductors. Reprogrammable read-only memories built with floating-gata MOS-transistors or with MNOS-structures can be included in control devices for tuning the microsystem to external signals, most expeditiously on single chips with n-MOS or CMOS logic. Programming can be done by laser beam, electron beam, or electron pulse. From the production standpoint, the yield of acceptable microsystems first without and then with control devices is estimated in standard probability terms on the basis of sliding redundancy. The requirements are then established which components for such a system must meet, the main criterion for suitability being the power rating. Interconnections should be sufficiently short to ensure minimum delay time. Elements with CMOS architecture and minimized output impedance are preferable for operation under high-capacitance loads. Design and yield calculations are shown for a superchip consisting of 16 active and 20 spare modules, module area  $10 \text{ mm}^2$  and control area  $1 \text{ mm}^2$ , also for a wafer carrying two kinds of active modules and spares without control. Figures 5; tables 1; references 18: 5 Russian, 13 Western.

## 15 Components, Hybrids, Manufacturing Technology

UDC 621.382

### Injection-Powered Silicon Transistor with High Current Gain

18600049d Moscow MIKROELEKTRONIKA in Russian Vol 17 No 5, Sep-Oct 88 (manuscript received 5 Aug 87) pp 472-474

[Article by V. I. Arshinov and Ye. V. Vekshina, Institute of Problems in Cybernetics, USSR Academy of Sciences]

[Abstract] The performance of a vertical injection-powered silicon transistor with lateral dielectric insulation is evaluated, such a device having essentially a four-electrode  $p^+$ -n-p-n $^+$  structure and featuring a high current gain. Its structure is approximately equivalent to two directly connected and functionally integrated transistor structures, a p-n-p driving transistor and an n-p-n switching transistor. Specimens of such a device were

produced on p-type substrates by doping with B, Sb, and P, by liquid-phase and gaseous-phase epitaxy, by photolithography for ion implantation and subsequent heat treatment with laser pulses. The current gain and the mean switching time were measured as functions of the collector current density and of the input power respectively. The current gain was found to peak at a current density about  $100 \text{ A/cm}^2$ ,  $h_{21eN}^p$  reaching 125 and  $h_{21eN}^p$  reaching 30. The mean switching time was found to decrease fast with increasing input power, to below  $10^{-9}$  s at about 0.080 mW and not further. The width of the space-charge regions limits the thicknesses of the active layer, small thickness of these layer facilitating fast resorption of minority charge carriers and shorts across them between space-charge regions causing the efficiency of injection to drop appreciably. The authors thank V. I. Stafeyev for interest and fruitful discussions. Figures 2; references 6: 3 Russian, 3 Western.

UDC 621.311:621.314.241

**Use of Electromechanical Frequency Converters for Sectionalization of Electric Power Generating Plants**

18600055a Minsk *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA* in Russian No 9, Sep 88 (manuscript received 23 May 86) pp 41-44

[Article by T. N. Strelova, engineer, and Ye. V. Kalent'ionok, candidate of technical sciences, docent, 'Labor's Red Banner' Belorussian Polytechnic Institute]

[Abstract] The role and the performance of an asynchronous synchronous electromechanical frequency converter in an electric power generating plant is analyzed, such a converter being coupled to the turbine shaft along the synchronous machine for the purpose of power system sectionalization. In addition to the set of two synchronous-induction machines and two variable frequency converters, it includes two voltage step-down power transformers and two supply voltage transformers as well as two automatic excitation regulators. The three principal advantages of this scheme are elimination of an extra conversion and attendant power losses, smaller installed power, and elimination of extra start-up equipment. The benefits of power system sectionalization are lower short-circuit currents, wider range of kvar regulation, better utilization of the regulating effect of the load, higher stability, and confinement of faults. Sectionalization makes it easier to optimize operation of the power system under varying conditions and to control transient processes, it not being necessary to change the mechanical torque angle but being sufficient to shift the e.m.f. phasor relative to the rotor position by changing the excitation voltage. Figures 2; references 6: Russian.

UDC 621.373

**Generators of Current Pulses for Several Simultaneous Loads**

18600055c Minsk *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA* in Russian No 9, Sep 88 (manuscript received 18 Jul 86) pp 53-56

[Article by G. M. Koliushko, candidate of technical sciences, V. V. Konotop, candidate of technical sciences, docent, G. L. Mezhibovskiy, engineer, O. S. Nedzelskiy, engineer, Ye. V. Platonova, engineer, and E. A. Shelekhov, engineer, 'Orders of Lenin and October Revolution' Kharkov Polytechnic Institute imeni V. I. Lenin]

[Abstract] The concept of a ring-circuit generator of current pulses for several simultaneous identical loads is described, such a type of generator having been developed to ensure operation of all commutator switches following buildup of charge and prior to discharge of current pulse. The design and performance analysis of such a generator, an essentially capacitive device with intrinsic inductance

and resistances, is based on a series of preliminary one-factorial mathematical experiments and an optimization process. Calculations are shown for a generator consisting of five identical sections, a nomogram having been constructed for determination of the minimum acceptable size of the distributor capacitor depending on the size ratio of the two discharge capacitors. Figures 3; references 4: Russian.

UDC 621.316.1:621.317

**Estimation of Energy Retained Upon Sudden Breaks in Urban Electric Power Distribution Networks**

18600055b Minsk *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA* in Russian No 9, Sep 88 (manuscript received 3 Oct 86) pp 45-46

[Article by V. N. Radkevich, candidate of technical sciences, docent, 'Labor's Red Banner' Belorussian Polytechnic Institute]

[Abstract] For the purpose of operational control of 6-10 kV urban electric power distribution networks during outages after faults, it is found to be necessary to estimate the energy retained upon sudden breaks. This energy, equal to the product of the mean users' active power (dependent on the instant of a break) and the mean length of outage time, is split into the energy retained from the instant a break occurs to the instant fault locating begins and the energy retained during the fault locating process. The second part of energy retained is more difficult to estimate, the algorithm being demonstrated on a typical section-by-section fault search. Figures 2; references 3: Russian.

UDC (621.311.4:665.6).001.5

**Dependence of Norms of Electric Energy Consumption for Petroleum Processing on Productivity of Processing Equipment and on Quality of Crude Oil**

18600062a Moscow *PROMYSHLENNAYA ENERGETIKA* in Russian No 9, Sep 88 pp 2-4

[Article by A. A. Saidov, doctor of technical sciences, Groznyi Institute of Petroleum imeni Academician M. D. Millionshchikov, and E. G. Asriyan, engineer, Specialized Management of Power Equipment Setup and Startup, 'Orgneftekhimenergo' (Petrochemical Power System Organization)]

[Abstract] Considering the imminent transition of petroleum processing plants to economic accountability, norms of electric energy consumption for petroleum processing are sought on the basis of their evident dependence on the productivity of processing equipment and on the quality of crude oil. An evaluation of this relation is made according to the principles of regression analysis. As a starting point, the power requirement representing energy consumption is

equated to a trinomial which includes an independent constant term in addition to a term proportional to the productivity representing the volume of finished product and a term proportional to the quantified quality of crude oil. On the basis of numerical data characterizing operation of the Novopolotsk plant, 14 regression equations are derived which yield the specific electric energy in kWh/ton consumed by air-vacuum coring, air coring, hydraulic scrubbing, and refining as a function of the equipment productivity for various grades of crude oil. Figures 3; tables 1; references 2: Russian.

UDC (621.515.5:62-624.6).004.67

**Norms for Scrapping Cable Products**

*18600062b Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 9, Sep 88 pp 19-20*

[Article by M. B. Gaber, engineer, and B. I. Golender, engineer, All-Union Scientific Research Institute for Organizing Production and Labor in Ferrous Metals Industry]

[Abstract] Considering that the iron and steel industry cannot obtain new cable products for plant operation without returning expendable nonferrous metal parts for their reprocessing, the All-Union Scientific Research Institute for Organizing Production and Labor in Ferrous Metals Industry and the All-Union Scientific Research Institute of Secondary Nonferrous Metals have jointly developed a method of setting stringent norms for scrapping cable products. These norms, separate for copper and aluminum, cover 19 cable products ranging from communication to power cables and from bare or insulated wire to shielded or armored cables as well as underground and underwater cables. The norms are based on calculation of the recovery index, this being the quotient of copper or aluminum yield per ton of scrapped cable of a given type by stock which the USSR State Planning Commission has allocated per ton or kilometer for production of that given type of cable. Individual norms for each type of cable as well as a composite norm have been set for planning purposes. Tables 1.

UDC 621.365.016.25.001.24

**Optimum Compensation of User's Reactive Power During Minimum-Load Hours in Power System**

*18600062c Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 9, Sep 88 pp 37-39*

[Article by G. V. Krasnik, engineer, State Design Institute No 1]

[Abstract] Compensation of user's reactive power is considered, this being particularly important during minimum-load hours in a power system. For the benefit of any user with a computer on premises, an iterative algorithm of automatic compensator regulation to the optimum level in terms of minimum electricity bill has been devised in accordance with well known active and reactive power relations. It is based on a universal optimization model and has been accordingly programmed not only for any form of the target function but also for any number of independent variables and any form of their constraints. The algorithm is demonstrated on a simple example of only one variable and its control by on-and-off switching of the compensator. The user operates 6000 h a year, which include 1200 h under minimum load, with an installed power costing 36 rubles/kW and consuming electric energy at a cost of 1 kopek/kWh. Figures 1; references 3: Russian.

UDC 697.34.001.2(430.1)

**Latest Developments in Central Heating Technology**

*18600062d Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 9, Sep 88 pp 43-44*

[Article by V. A. Lukin, engineer]

[Abstract] A symposium on "Latest Developments in Central Heating Technology in the FRG" was held in March 1988 in Frankfurt-am-Main under the joint sponsorship of the Association of German Electric Power Plants (FRG) and the Moscow City Council of Workers' Deputies. Among the 15 papers presented, most interesting were those dealing with vapor-gas turbines and "circlofluid" boiler furnaces. The main features of boilers operating with these furnaces are high efficiency, small size, adaptability to a broad range of fuels, low emission of nitrogen oxides owing to low-temperature multistage combustion, and desulfurization of flue gases by precipitation of SO<sub>2</sub> with CaO followed by conversion of CaSO<sub>3</sub> into CaSO<sub>4</sub> through oxidation. The capacity of binary heat and electric power plants has already reached 400 MW. A new 700 MW plant operating at 46 pct thermal efficiency in the condensation mode has already been built, but it still runs on gaseous fuel only. A control system "TELEPERM ME" for controlling the technological processes in these plants has been developed by "Siemens AG." Other firms involved include "AEG Kanis" in Nuremberg, "Deutsche Babcock" in Offenbach-am-Main, and "Stadtwerke" in Duesseldorf.

UDC 621.315.61:621.317.335.3.088.3

**Optimum ELectrical Thickness of Specimen for Dielectric Measurements By Resonator Method**  
*18600043a Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 37-39*

[Article by Ye. B. Zaltsman]

[Abstract] The problem of determining the optimum electrical thickness of a specimen for dielectric measurements in a resonator or waveguide is analyzed again, this problem having been tackled already over 20 years ago by the same author and more recently by other authors (R. J. Cook in 1973, U. Stumper and E. Ni in 1985). According to the definition of electrical thickness of a dielectric in an electromagnetic field as  $2\pi$  times the ratio of geometrical thickness to field wavelength and considering the inevitable existence of a skin-effect layer in the metal wall, the specifications in the USSR All-Union State Standard 12723-67 are correct. There is no evidence indicating that the optimum electrical thickness equals half the field wavelength, inasmuch as the British authors' assertion that the possible mechanical or electrical gap between base surface of the specimen and plane of the equivalent short circuit through metal has a negligible effect on the dielectric permittivity of the material is unsupportable. Figures 2; references 8: 5 Russian, 3 Western.

UDC 621.3.011.4.08:681.32

**Instrument Sh2-9 With Microprocessor for Measuring Dielectric Parameters of Materials**  
*18600043b Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 39-41*

[Article by Yu. V. Podgornyy, A. A. Shakhmatov, A. P. Luchnikov, and A. T. Shermukhamedov]

[Abstract] A new instrument for measuring the dielectric parameters of films has been developed which includes data processing components for computer-aided operation. This Sh2-9 instrument combines measurement of the dielectric permittivity by the constant-distance method and measurement of the loss tangent by the constant-capacitance method. Measurement errors are minimized by use of a high-precision thickness gage and by an extra large separation of the electrodes. The instrument includes an electric motor with a mechanical rotation-to-translation converter for large linear displacement of the movable electrode and a fan-cooled thermomechanical converter for small linear displacement of that electrode, another electric motor for rough movement into resonance position, a capacitive displacement transducer, an inductance coil and a variable capacitor, an amplitude detector and an analog-to-digital converter, a digital-to-analog converter and a master oscillator, a frequency-to-code converter, a computer with keyboard, a generator of control pulses for both electric motors and for the thermomechanical converter through a special control device, and an indicator panel. Figures 1; tables 1; references 2: 1 Russian, 1 Western.

UDC 681.787.089.5

**Nonlinearity of Superconducting Quantum Interferometer**  
*18600043g Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 48-49*

[Article by Ye. L. Altshuler and A. F. Satrapinskiy]

[Abstract] Design and performance of a SQUID for measurement and comparison of direct currents are analyzed, of concern being the nonlinear dependence of the effective magnetic flux on the current to be measured. This nonlinearity is traced to a variable mutual inductance of the quantizing circuit and the measuring coil, the variability of their mutual inductance being caused by changes in their geometrical dimensions and by changes in the magnetic susceptibility of the quantizing device. Changes in the geometrical dimensions occur

owing to the dependence of the magnetic-field penetration depth in the superconducting components on the intensity of the magnetic field, the dimensions of the measuring coil also depending on the ponderomotive force of the magnetic field. Changes in the magnetic susceptibility of the quantizing device occur owing to variability of magnetic impurities, owing to magnetization of superconductors, and owing to instability of frozen-in magnetic fluxes. Theoretical quantitative estimates of the resulting nonlinearity based on these factors are compared with experimental data, measurements with a SQUID inside a cryostat at 4.2 K temperature having been made with two current sources (0.1-1 A and 10-20 A) and two digital voltmeters. The superconductor components of two different SQUIDs were made of 99.9 pct pure Nb, respectively with and without a Cu sheath. Figures 2; references 5: 1 Russian, 4 Western (1 in Russian translation).

UDC 621.396.6:681.7.068

**Transfer Function of Compound Fiber-Optic Delay Line**

18600042a Moscow RADIOTEKHNIKA in Russian  
No 8, Aug 88 (manuscript received, after completion,  
23 Mar 88) pp 8-10

[Article by A. A. Bortsov, V. V. Grigoryants, Yu. B. Ilin,  
and V. N. Konstantinov]

[Abstract] The transfer function of a compound fiber-optic delay line consisting of several multimode fibers is derived and analyzed, such fibers being compatible with any standard light source and being readily coupled to optical components on the receiver side. A line consisting of three stepped-index fibers is considered, a sinusoidally modulated optical signal from a light-emitting diode passing through one segment and then through two parallel segments to a photodetector. Assuming a uniform excitation of the first segment and a regular geometry of all three segments, an expression for the transfer function of such a line in the paraxial approximation is derived from the general definition on the basis of a one-parametric description. Numerical calculations reveal how both the modulus of the complex transmission coefficient and the effective time delay depend on the relative radial misalignment of the exit from the first segment and the merged entrances to the two parallel segments. Figures 2; references 3: 2 Russian, 1 Western (in Russian translation).

UDC 681.7.068

**Probability of Atmospheric Electricity Damaging Optical Cable Line**

18600042b Moscow RADIOTEKHNIKA in Russian  
No 8, Aug 88 (manuscript received 13 Jan 88) pp 17-21

[Article by V. N. Korshunov and E. L. Portnov]

[Abstract] The probability of a thunderstorm damaging an optical cable line is estimated on the basis of lightning frequency and density statistics along with cable design parameters. Into consideration are taken cloud-to-cloud as well as cloud-to-ground discharges, also that the dielectric components of an optical cable line with no metal components except protective sheaths are made vulnerable only by direct strikes and induced arc discharges. Numerical design data and surge test data pertaining to OZKG-1 cables indicate possible countermeasures to increase the immunity of optical transmission lines exposed to atmospheric electricity. Figures 3; tables 1; references 11: 6 Russian, 5 Western.

UDC 532.552

**Acoustooptic Devices for Fiber-Optic Communication Lines**

18600042c Moscow RADIOTEKHNIKA in Russian  
No 8, Aug 88 (manuscript received 28 Aug 87) pp 22-27

[Article by S. N. Antonov and V. M. Kotov]

[Abstract] Acoustooptic devices are considered for use in fiber-optic communication lines, the main problem being adequate optical matching. An engineering analysis of the performance characteristics of an acoustooptic modulator operating in the Bragg mode with a single diffraction peak when coupled to a single-mode fiber indicates the feasibility of its design optimization for high speed and decoupling of channels with minimum diffraction loss and minimum parasitic leakage. A scheme of a controllable coupler is proposed on this basis where a  $\text{TeO}_2$  crystal operates as a  $2 \times 2$  commutator switch between two identical lenses in quadrature with a common focus at the center of the crystal, the necessary condition being that the acoustic vectors originating from a common point have their end points on the wave surface of the acoustooptic medium. Multiplexing optical signals of various wavelengths into one fiber and demultiplexing optical signals from a multimode fiber can also be done by an acoustooptic device, as has been demonstrated experimentally with a  $\text{TeO}_2$  crystal between two  $\text{LiNbO}_3$  piezoelectric transducers bonded to it on opposite faces perpendicular to its axis. Figures 7; tables 1; references 13: 8 Russian, 5 Western (2 in Russian translation).

UDC 681.7.068

**Fiber-Optic Spectral Displacement Transducer**

18600042d Moscow RADIOTEKHNIKA in Russian  
No 8, Aug 88 (manuscript received, after completion,  
6 Jan 88) pp 31-33

[Article by B. G. Gorshkov and Yu. B. Pervushin]

[Abstract] A fiber-optic spectral transducer for measuring small displacements is described, radiation from a wideband source passing through an optical fiber to a Fabry-Perot interferometer acting as sensor. In order to determine the interferometer base and thus the sought displacement, it is necessary to analyze the spectrum of radiation passed by the interferometer. Spectrum analysis by means of an electromagnetically or piezoelectrically driven scanning second interferometer carrying a photodetector is preferable to use of a diffraction grating. Calculations based on specific interferometer data yield the range of measurable displacements, namely the theoretical upper limit. Other interferometers such as a Mach-Zander or multipass interferometers can be used instead of a Fabry-Perot and other quantities such as pressure, temperature, or linear acceleration can be measured with this transducer. Figures 3; references 3: 2 Russian, 1 Western.

UDC 681.7.068

**Optical Hough Transformation and Subsequent Data Transmission Over Kilometer Long Optical Fiber in Real Time**

18600042e Moscow RADIOTEKHNIKA in Russian No 8, Aug 88 (manuscript received, after completion, 25 Mar 88) pp 34-37

[Article by G. G. Voyevodkin, Ye. M. Dianov, A. A. Kuznetsov, and S. M. Nefedov]

[Abstract] Transformation of a point into a sinusoid is considered for subsequent transmission of optical data over long distances in real time, transformation into a sinusoid being an extension of the Hough transformation into a straight line and of the equivalent to it Radon integral transformation. The feasibility of such a scheme with use of a Dove prism and a concave spherical diffraction grating is examined, astigmatism of the latter making the transformation possible. This is demonstrated on a normally incident parallel beam of monochromatic light and a diffraction grating with vertical slits which forms two astigmatic segments in quadrature while the paper is moved away from it. In the case of polychromatic incident light not a point but a spectrum of points is formed along a segment so that monochromatic beams of various wavelengths enter the optical fiber sequentially. In the experiment a KGM-75 quartz-halogen lamp served as source of white light, which was passed through an LOMO-VU-200 collimator to a diffraction grating with 1200 lines/mm and a 250 mm radius of curvature. The transform was transmitted over a 1 km long stepped-index optical fiber with a quartz core 0.055 mm in diameter, with an attenuation of approximately 20 dB/km over the 550-650 nm range of the spectrum. Objectives and a plane diffraction grating with 1200 lines/mm were placed on the receiver side. Figures 4; references 11: 3 Russian, 8 Western.

UDC 681.068

**Optoacoustic Converter for Fiber-Optic Communication Lines**

18600042f Moscow RADIOTEKHNIKA in Russian No 8, Aug 88 (manuscript received, after completion, 10 Aug 87) pp 44-46

[Article by Ye. S. Avdoshin]

[Abstract] An optoacoustic device is described which converts, in two stages, laser radiation into sound on the receiver side of a fiber-optic communication line. It comprises a photodetector and an electrodynamic loudspeaker inside a common cup chamber. The photodetector, an FD-271 p-i-n silicon photodiode, has a high threshold sensitivity of 0.4 A/W to 850 nm radiation with low noise and a low inertia with a response time of only 3 ns at that wavelength. The photodiode is carefully mounted inside a precision coupling which connects it to a 1.5 m long KVSP-50 multimode fiber-optic cable with

a quartz core 0.050 mm in diameter. The electrodynamic loudspeaker on the output side of the photodetector consists of a Sa-Co magnet with a centered pole shoe producing a magnetic induction of 0.1 T in the air gap and a 0.050 mm thick flexible polymer diaphragm with an audio coil. The converter produces a sound pressure of 27.5 Pa/mW. Its frequency characteristic, measured with amplitude-modulated radiation from an ILPN-301 infrared semiconductor laser, departs not more than 12 dB from flatness over the 150-5000 Hz range, nonlinear distortions at 1000 Hz not exceeding 2 pct with 2 V at the loudspeaker input. The converter is compatible with a fiber-optic microphone. Figures 5; references 4: 3 Russian, 1 Western.

UDC 681.7.068

**Automatic Instrument for Measuring Mechanical Stresses in Fiber-Optic Blanks by Method of Optical Polarization**

18600042g Moscow RADIOTEKHNIKA in Russian No 8, Aug 88 (manuscript received 18 Dec 87) pp 67-72

[Article by I. V. Aleksandrov, S. P. Vikulov, M. Ye. Zhabotinskiy, V. V. Romanovtsev, A. N. Tuzov, S. Ya. Feld, and O. Ye. Shushpanov]

[Abstract] An instrument for nondestructive measurement of mechanical stresses in fiber-optic blanks by the method of optical polarization is described, this instrument having been fully automated for simultaneous precise measurement of whole wavelengths and fractions thereof constituting the path difference between two orthogonally polarized components of the probing light beam. The first part of the instrument consists of a light source, a collimator which produces a parallel beam wider than the inspected sample, an infrared filter which cuts out thermal radiation, and a polarizer film. Linearly polarized light passes through sample inside a cell with immersion fluid, then through a converging lens, a quarter-wavelength compensator plate, and an analyzer film to a spectral filter. The latter extracts a monochromatic component from the probing light beam and is followed by a photodetector matrix array of 1024 charge-coupled devices spaced 0.015 mm apart. The analyzer is rotated by a stepper motor in 0.15 deg steps, or is electronically scanned when a vidicon serves as photodetector. The instrument, with readout and recording, is controlled by a remote NORD-10 central minicomputer with the aid of a CAMAC crate. The standard deviation of phase difference between orthogonally polarized light beam components, proportional to their path difference and measured without a sample so as to reduce the systematic errors to zero and to allow for random errors only, does not exceed 0.5 deg. Figures 5; tables 1; references 15: 9 Russian, 6 Western.

UDC 681.7.068

**Retention of Polarization in Anisotropic Single-Mode Optical Fibers With Elliptically Stressing Sheath**

18600042h Moscow RADIOTEKHNIKA in Russian No 8, Aug 88 (manuscript received 21 Jan 88) pp 90-95

[Article by A. Yu. Aleksandrov, V. V. Grigoryants, A. N. Zalogin, G. A. Ivanov, V. A. Isayev, S. M. Kozel, V. N. Listvin, Yu. K. Chamorovskiy, and R. V. Yushkaytis]

[Abstract] The performance of anisotropic single-mode optical fibers is analyzed for the longitudinal distribution of coupling between orthogonal polarization modes. A short fiber segment with a "compensated" index profile and with a rigid elliptical protective sheath of pure or fused quartz around the quartz core is considered, two equipotent orthogonal polarization modes being excited at the fiber entrance and the dispersion of the normalized intensity of one of them at the fiber exit being identically equal to the polarization retention factor times double the fiber length. The longitudinal distribution of the coupling coefficient for such polarization modes was measured in an experiment with a He-Ne laser as light source, a fiber segment in a thermostat between a polarizer and two analyzers, one for the reference channel and one for the measuring channel, a detector photodiode with a narrow-band amplifier and a Schmitt trigger in the reference channel, a detector photodiode and a synchronous amplifier in the measuring channel, and for data processing an analog-to-digital converter followed by a minicomputer. The results should be useful for design and manufacture of such optical fibers with a low absorption coefficient and a small polarization retention factor. Figures 7; references 13: 6 Russian, 7 Western.

UDC 621.396.67.049:621.375.826:681.787

**Two Schemes for Gravitational-Wave Antennas of Laser-Interferometer Type**

18600043e Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 88 pp 45-46

[Article by L. F. Vitushkin, N. A. Rzaumovskiy, and M. Z. Smirnov]

[Abstract] Two optical schemes for gravitational-wave antennas of the laser-interferometer type with two orthogonal arms are described, each scheme combining the advantages of two different interferometers. In the first scheme a resonator interferometer with a delay line and an optically pulse-pumped interferometer with pulsed reception are combined, the two mirrors in each arm being positioned for multiple reflection without splitting of the light beam. In the second scheme a resonator interferometer with a delay line and a high-Q multiple-pass cavity or a multiple-pass multiple-beam interferometer are combined for easier extraction of millisecond and thus relatively short gravitational pulses from laser background radiation noise, which would otherwise be difficult even though gravitational radiation from pulsating cosmic sources arrives on earth with a power density five orders of

magnitude higher than that of gravitational radiation arriving from continuous-wave cosmic sources. Inclusion of a multiple-pass multiple-beam interferometer raises the sensitivity of a gravitational-wave antenna by a factor equal to the square root of the ratio of delay time to pulse duration. Figures 1; references 8: 4 Russian, 4 Western.

**Interference Immunity of Simultaneous**

**Information Signal and Service Signal Transmission Over Fiber-Optic Channel**

18600052c Moscow ELEKTROSVYAZ in Russian No 7, Jul 88 p 27

[Article by R. I. Levitan; annotation of article No 1354-sv deposited at the Central Scientific-Technical Institute 'Informsvyaz', 16 pp with 1 figure and 10 bibliographical references]

[Abstract] Simultaneous transmission of an information signal and a service signal by superposition over a fiber-optic channel operating by the pulse-width-modulation method is analyzed for interference immunity. The error coefficient and the signal-to-noise ratio at the output of the decision element are calculated for double-sideband and single-sideband modulation of the information signal with superposition of the service signal in each case.

**High-speed Phototransistor of ZnSe GaAs Heterostructure**

18600056a Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 22 No 8, Aug 88 (manuscript received 16 Apr 87, signed to press 5 Jan 88) pp 1353-1358

[Article by B. V. Zhuk, A. A. Zlenko, A. M. Prokhorov, Ye. N. Razov, and Ye. A. Shcherbakov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] The operating mechanism and the performance characteristics of an n-p-n heterostructure phototransistor with a thin narrow-band "floating" base and a reverse voltage bias on the collector junction is analyzed, high time resolution and thus high speed for its use as a photodetector. Generation of electron-hole pairs, following absorption of incident light by both base and depletion layer, is followed by relaxation of excess holes in the base and recovery of the barrier after expiration of the light pulse. Theoretical calculations on the basis of such a model take into account limitation by space charge in the emitter junction. An experiment was performed with a ZnSe/GaAs heterojunction phototransistor, its double-layer emitter consisting of an intrinsic region adjacent to the GaAs substrate and a heavily doped region adjacent to the base without discontinuity. The phototransistor had a surface area of  $2.10^{-3} \text{ cm}^2$ . Its pulse response characteristic was recorded on an oscilloscope, with the light pulse power varied over the  $10^{-8}$ - $10^{-4}$  range using light of 840 nm wavelength, and was monitored by an LFD-2 germanium avalanche photodiode. Measurements were also made to determine the dependence of the dark current on the bias voltage. The results indicate the feasibility of attaining a 100 A/W sensitivity at a speed of 200 MHz. The authors thank G. P. Shipulo for interest and I. A. Zhukov for assistance. Figures 4; references 10: 2 Russian, 8 Western.

**Mechanisms of Radiative Recombination in Heavily Doped and Compensated GaAs**  
*18600056b Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 22 No 8, Aug 88 (manuscript received 11 Jun 87, signed to press 21 Jan 88) pp 1359-1364*

[Article by V. L. Korolev and V. G. Sidorov, Krasnoyarsk Polytechnic Institute]

[Abstract] The theory of luminescence by heavily doped and compensated semi-conductors has been quantitatively verified on GaAs photodiodes grown in a single cycle of liquid-phase epitaxy and doped with amphoteric impurities in a solution-melt. Specimens of p-n-GaAs:Si structure containing only shallow donor and acceptor states, with Si concentrations of  $(1\text{-}7)\cdot10^{18} \text{ cm}^{-3}$  and with impurity compensation levels from near zero to near unity, were used for measurement of luminescence spectra at temperatures of 64-300 K at excitation intensity levels of  $3\cdot10^{17}\text{-}10^{20} \text{ phot}/(\text{cm}^2\cdot\text{s})$ . As excitation source served an LG-75 laser. The concentrations of majority charge carriers  $n_0, p_0$  was measured by the capacitance-voltage method with layer-wise surface etching. The temperature dependence of the shortwave band in the spectra indicates recombination of free electrons and free holes during band-to-band transitions, no shortwave band and only a longwave band appearing at higher temperatures. The spectra reveal also tail-to-tail and band-to-band recombination channels. The temperature, excitation level, Si concentration, and compensation level dependence of the GaAs:Si luminescence spectrum is found to be analogous to that of doubly doped p-n-GaAs:Si,Sn and p-n-GaAs:Ge,Sn semiconductor structures. Figures 3; references 15: 14 Russian, 1 Western.

**Decay of Acoustoelectronic Interaction During Photoconduction Transients in CdS**  
*18600056c Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 22 No 8, Aug 88 (manuscript received 31 Aug 87, signed to press 5 Feb 88) pp 1486-1488 [Article by V. I. Mirgorodskiy and S. V. Peshin, Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow]*

[Abstract] Decay of acoustoelectronic interaction was utilized for an experimental study of the photoconduction kinetics in CdS piezosemiconductor crystals following turn-on and turn-off of a brightening light source. An acoustic shear wave was passed through a CdS crystal normally to the hexagonal c-axis while being shifted so as to intersect it at various different points. An incandescent lamp with standard 3S-2 plus S3S-24 filters served as photoconduction exciting light source, the electrical conductivity of a crystal changing as the intensity of illumination increased and decreased. After a crystal had been held in darkness for 5 min, light was turned on and following a 0.1 s long transient period remained on for 5 min before being turned off. The power of sound passing through a crystal as well as both real and imaginary parts of the electrical conductivity were recorded for measurement

throughout both turn-on and turn-off transients. The same test was performed on three dimensionally but not otherwise identical CdS crystals. The results reveal a dip with hysteresis in the conductivity dependence of the acoustic power, the hysteresis pattern depending on the degree of electrical nonhomogeneity of a crystal and vanishing only in an electrically homogeneous one with both uniform generation and uniform recombination of charge carriers. Figures 2; references 5: 4 Russian, 1 Western.

**Instability of Cold Electrons in Semiconductors**  
*18600056d Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 22 No 8, Aug 88 (manuscript received 6 Nov 87, signed to press 25 Mar 88) pp 1520-1524*

[Article by A. I. Vakser, Institute of Radiophysics and Electronics, UkrSSR Academy of Sciences, Kharkov]

[Abstract] Instability of semiconductor electrons cooled by the Peltier effect inside a thermostat is analyzed in the one-temperature and electrical quasineutrality approximations, considering a nondegenerate homogeneous n-type semiconductor material with a standard forbidden band. The two coupled one-dimensional differential equations of heat diffusion and electric current conduction satisfying heat balance and current continuity in a semiconductor bar of finite length are solved first analytically for asymmetric thermal boundary conditions and continuity of the electric potential at each boundary, taking into account the Thomson effect. Subsequent graphical solution yields the longitudinal temperature profile and the current-voltage characteristic. These indicate when and where instability occurs, inasmuch as the Peltier effect and the Joule effect independently heat the electrons when current flows in the forward direction but the Peltier effect cools them while the Joule effect still heats them when current flows in the reverse direction. The author thanks F. G. Bass, Z. S. Gribnikov, Yu. G. Gurevich, B. S. Kerner, and V. I. Tolstikhin for discussing the results. Figures 2; references 12: Russian.

UDC 621.391:534

**Maximum Transmission Coefficient of Surface-Acoustic-Wave Convolvers**

*18600057j Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 8, Aug 88 (manuscript received 28 Jan 87) pp 1780-1784*

[Article by G. D. Lobov, S. A. Fedorov, and V. V. Shtykov]

[Abstract] The operation of surface-acoustic-wave convolvers with internal polarization nonlinearity is analyzed theoretically for the feasibility of maximizing the transmission coefficient, namely by matching the crystal orientation and the topology of electrodes with the sound concentration. Calculations are based on the complete equivalent electric circuits of a current generator with its internal capacitance and resistance, a variable compensating inductance, and a load resistance all connected in parallel across it. Numerical

estimates for LiNbO<sub>3</sub> and Bi<sub>4</sub>Ge<sub>3</sub>O<sub>12</sub> convolvers with a -40 dBm internal loss factor and a 25 MHz bandwidth operating with 0.010 ms interaction time at the 100 MHz center frequency indicate that their transmission coefficient can be increased by 20-30 dB. Figures 3; references 7: 3 Russian, 4 Western (1 in Russian translation).

UDC 621.391:584:535

**Selection of Optimum Optical Signal for  
Acoustooptical Spectrum Analyzers With Sound  
Attenuation**

*18600057h Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 8, Aug 88  
(manuscript received 22 Sep 86) pp 1757-1764*

[Article by A. V. Yurchenko and Ye. D. Belokolos]

[Abstract] Considering that sound attenuation in acoustooptic devices degrades their performance, the problem of maximizing the fraction of light energy incident on a diffraction spot of given dimension in a spectrum analyzer is formulated by application of the variational principle. The problem is solved for a given modulator aperture and a given band of space frequencies, assuming that the divergence of light waves is smaller than the divergence of sound waves. The integral resolving power of an acoustooptic device is then calculated on this basis, acoustically modulated light passing through a converging lens to the analyzer in the focal plane of that lens for Fourier transformation. Next is calculated the efficiency of the device with an optical input signal which has a uniform distribution in the direction of the sound wave, whereupon its distributions are determined which will maximize either the efficiency or the resolving power of such a spectrum analyzer. Figures 4; references 12: 8 Russian, 4 Western (2 in Russian translation).

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